



Markets for Cleaner Air: Cap & Trade Simulation

Facilitator's Guide

About this Guide and the Simulation

Simulation purpose

The purpose of the Cap & Trade Simulation (“the simulation”) is to allow participants to put the theory of cap and trade into practice. Participants are assigned a power plant to manage and are required to develop compliance strategies to achieve an emission target

Organization

This guide is organized into an introduction, instructions for using the simulation in the classroom, frequently asked questions, topics for further discussion, and additional resources about cap-and-trade programs.

Simulation system requirements

Each participant or team will run a separate instance of the simulation. Therefore, each participant or team will require a computer with the following software:

- Windows XP, Vista, or Windows 7; and
- Microsoft .Net 3.5 or greater.

The simulation does not use networking functionality so the computers do not need to be networked. You will, however, need a mechanism for distributing the simulation software to participants (e.g., USB or network drives). The simulation does not install any software or edit any settings on the participant or facilitator's computers.

Licensing and contact information

The simulation and its documentation were developed by the United States Environmental Protection Agency (EPA) to educate people about the cap-and-trade policy approach. The software and documentation are available at no cost. If you have questions or wish to request the most recent version of the software, please contact:

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Introduction

Goal of the Facilitator's Guide

The purpose of this guide is to provide information necessary to understand the principles behind the simulation and to better facilitate the use of the simulation. There is no single best way to incorporate the simulation in a course or conference. You may use the simulation as an adjunct to other materials or exercises, or as the cornerstone for a course or conference. This guide offers some options for using the simulation in a classroom or conference setting and explains some of the underlying process and theory. It also describes how you may change the parameters of the simulation to suit the specific needs of a course or conference.

Reinforcing participant understanding

As facilitator, you must understand the operations of the simulation and be able both to explain how to use the simulation and isolate various elements for instructional purposes. As such, this guide assumes that you are familiar with the *Participant's Guide*.

Learning objectives

The primary objective of the simulation is to educate participants about market-based environmental strategies. You should be able to articulate to participants the following specific objectives of the simulation:

1. Gaining a clearer understanding of how cap-and-trade programs employ market concepts to control emissions;
2. Learning how to design cost-effective responses to environmental requirements; and
3. Acquiring a "cap-and-trade" vocabulary.

How to use the simulation in class

This section provides details about facilitating the game and builds on the concepts covered in the *Participant's Guide*. It covers additional information about the rules of the game, suggestions for how to develop and implement a reduction strategy, and details on how to use the Registry application which is a special companion application that helps you facilitate the simulation.

Understanding and explaining the basics of the simulation.

Purpose of the simulation

The purpose of the simulation is to provide participants with an instructional tool for putting the theory of cap and trade into practice. Participants are assigned a power plant and must develop compliance strategies to achieve an emission target.

Levels of play and scenarios

There are two levels of play – Beginner and Advanced. The *Participant's Guide* explains the differences between the two levels of play. In addition, the simulation offers two different cap-and-trade programs. The first is an SO₂ program and the second is a CO₂ program. The main differences between the SO₂ and CO₂ versions are that they offer different control technologies to reduce emissions (e.g., scrubbers vs. carbon capture), different coal types/blends, and the CO₂ variant provides the option to invest in emission offset projects to comply with the emission reduction requirements.

Rules

Participants are required to meet demand for electricity by producing sufficient electricity at the simulated facility they manage, to report all allowance transfers to Ecoland's government (typically the facilitator), and to possess at least one allowance or offset for each ton of SO₂ or CO₂ emitted during each compliance period.

Score

At the end of each period, the simulation will provide a period score and average score for the participants. As the *Participant's Guide* indicates, the score is based upon multiple factors, including whether the participant's power company:

1. Met customer demand for electricity;
2. Held sufficient allowances and offsets to compensate for total emissions;
3. Experienced a change in profitability; and
4. "Banked" surplus allowances and offsets for future use.

The *Participant's Guide* intentionally avoids providing further details about how the score is calculated because that information could be used by participants to "game" the scoring system. It is possible to use the Registry application (see *Facilitation of Games* section below) to change certain parameters that affect the score. Additional information concerning scoring is provided in the *Frequently Asked Questions* section below.

Offset projects

As noted earlier, offset projects are only available in the CO₂ scenario of the simulation. Approved offset projects provide a participant with offsets that can be used in a manner similar to emission allowances. The use of offsets for compliance can be limited to a specific percentage (e.g., no more than 10%) of a participant's total emissions. As facilitator, you can modify this setting (see *Facilitation of Games* section below). Offsets can be traded in the same way as allowances. However, participants must be clear about whether offsets or allowances are being sold or purchased, as the participants may set different prices for offsets or allowances. The value of offsets may differ from allowances because the use of offsets for compliance is constrained by the usage limits.

When a participant considers investing in an offset project, the simulation presents a range of costs and range of potential offsets the project will generate. Only after the participant chooses to invest will they learn the true cost and actual offsets created. Participants should be instructed that

approval of offset projects is not guaranteed in the advanced level of play, and that the offset project details include the likelihood of project approval. Projects that are not approved still incur project design and development costs. This information is also presented in the offset project details. Following the investment in a project or advancement to the next compliance period, the chance of approval for the next project is reduced, the range of costs is increased, and the range of offsets generated declines. This is designed to reflect the concept that the most cost-effective projects are often selected first. For more information about offsets, see the *Frequently Asked Questions* and *Additional Information Resources* sections below.

Efficiency projects

Efficiency projects allow participants to invest in programs that will lower demand for electricity. Information about the cost of the project and the percent reduction in demand is displayed as a range of values. Only after the participant chooses to invest will they learn the true cost and actual demand reduction. It is also important for participants to remember that these projects lower demand. In order to realize corollary emission reductions, participants will need to reduce their electricity generation at one or more electric generating units. The cost-per-ton range displayed in the efficiency project details assumes an average cost per ton for the participant's entire fleet of units. Thus, by lowering generation at a high-emitting unit (usually coal-fired units) a participant may be able to reduce emissions at a cost lower than that displayed in the simulation. Conversely, lowering generation at a low-emitting unit may mean that emission reductions will cost more than the amount displayed in the efficiency project details.

Game events

In the advanced level of play, participants may learn of randomly generated game events which are displayed in the Events panel and may alter their compliance strategy. These events occur at the beginning of each compliance period and can affect demand for electricity (e.g., new factories, population declines), the cost of fossil fuels (e.g., increased/decreased demand for coal), or the cost of new air pollution controls (e.g., changes in steel prices, cost reductions for components). The events may be permanent or temporary (i.e., for a single compliance period).

Understanding and explaining options for strategy implementation

The *Participant's Guide* provides an overview of the various options for reducing emissions. As facilitator, you should become familiar with how to perform each type of action in the simulation before employing the simulation in a classroom or conference setting. Depending upon the time available and level of understanding by the participants, you may find it useful to demonstrate some of the reduction options using one of the simulated power companies as an example.

Participants will also need to devise a strategy for implementing the required reductions at the lowest cost. The strategy may shift as the simulation progresses in response to events and the allowance market. However, there are some general guidelines that can help participants develop and implement a reduction strategy.

- Pursue “low hanging fruit” first
 - Offset projects and efficiency projects become more expensive over the course of the simulation. In addition, the number of offsets from an offset project and the demand reduction from an efficiency project decline as the simulation progresses. Similarly, in the advanced version the odds an offset project is approved declines.
 - Shifting generation between units and switching fuels are easy ways to lower emissions early in the simulation.
- Use the flexibility provided by the market
 - Buying allowances from other participants that can reduce emissions at a lower cost may allow a participant to comply with emission limits at a lower cost than if they were to install controls or add new generating units. Details about most control options will include an average price-per-ton for reductions that a participant can use in establishing prices for buying or selling allowances. In general, a participant should identify the least expensive reduction option and decide whether they are able to purchase allowances for less than the cheapest option available, or whether they can sell the allowances for more than the cheapest option available.
- Be alert to both regional resources and game events
 - Each participant is located in a different region and has resources specific to that region available to them. Some participants may have access to considerable wind, making wind power more economical, while other participants may be located in a sunnier region, making solar the better choice. Information about resource availability is displayed in the **Add Unit** window of the simulation and the *About Ecoland* section of the *Participant's Guide*.
 - During each period in the advanced version of the simulation, certain “events” are generated by the simulation. Participants should be alert to these events as they can impact the price of controls, level of electricity demand, or price of fossil fuels.
- Be alert to demand and the profit ratio
 - The main goal of the simulation is to remain in compliance with emission limits. Therefore a participant's score will be affected by how successful they are in meeting the emission limits. However, if a participant is unable to meet demand, they will be subject to a “brown-out” penalty (see *Facilitation of Games* below).
 - Another goal of the simulation is to reduce emissions in the least expensive manner. A participant that maintains a high profit ratio while meeting demand and staying in compliance will receive a higher score. See the *Frequently Asked Questions* section of this guide for a more detailed discussion of the score.

You should refer to the *Participant's Guide* for a detailed explanation of the following options available to participants: (1) reducing facility emissions by shifting generation, adding controls, or adding

new units; (2) reducing electricity demand through energy efficiency programs; (3) reducing emissions outside the electricity sector with offset projects; (4) trading emission allowances and offsets; and (5) adjusting strategies to accommodate unplanned events.

Facilitating the simulation

As facilitator, you are responsible for explaining the rules of the simulation and for answering any questions participants may have. Once the simulation has begun, your main responsibility is to track trades and, possibly, to facilitate trading.

Assigning power companies

While the simulation may be used with a single participant representing a power company, experience has shown that participants learn more and enjoy the exercise more when working in small teams of two to four participants. You should assign specific power companies to each participant or team of participants. When the participants start the simulation they will select their assigned power company from the list of available power companies and use this information for conducting transactions and reporting information to you. You should also specify the pollutant and level of play. All participants must select the same pollutant and level of play.

After a participant selects the power company, emissions control program, and level of play, the simulation will randomly assign several fossil-fueled electricity generating units to their power plant. Initial electricity demand will vary by plant but will be set below the combined maximum potential generation of all the units assigned at the start of the simulation. Initial allowance allocations will also vary by plant because the allocations are based on the size and type of generating units assigned to the plant at the beginning of the simulation.

Trading

Participants may desire to buy and sell allowances as part of their compliance strategy. Because the simulation does not communicate electronically between participants, the buyer and seller must both manually enter the transaction into their instance of the simulation. To initiate a trade, a participant must identify a trading partner (typically done by walking around the room inquiring about other participants' interest) and agree on a compliance instrument (i.e., allowances or offsets), quantity, and price. As facilitator, you can either allow participants to arrange trades between themselves or serve as the broker of trades. If the latter method is selected, participants should submit trade requests to you. You can then match buy requests to sell offers and allow participants to agree on a price and quantity. Another option is to use a white board, flip chart, or similar device for participants to "post" their sales offers or purchase requests. Once two participants have agreed on a price, quantity, and instrument (allowances or offsets), both participants must enter the trade into their instance of the simulation so the allowances/offsets are added to or deducted from their total. The selling party should also report the transaction to you so that you can enter the information in the Registry application for all participants to see.

Advancing to the next compliance period

As facilitator, you must inform the participants when to move to the next compliance period. All participants must move to the next compliance period at the same time. Upon moving to the next compliance period all actions from the previous period are “locked”. Therefore participants should be sure they are in compliance, meeting demand, and done trading at the end of each period. The length of each compliance period and the method for informing participants that they must move to the next compliance period is at your discretion. One option you have is to monitor activity and as it dies down give a five minute warning. Another option is to provide a time limit for each period. Regardless of the method you choose, you should provide a warning before each period ends so that participants have a chance to make any last minute adjustments.

Participants can click the **Advance to Next Period** button on the toolbar to see a summary of their compliance activity and performance. Participants should not click the ‘Yes’ button to confirm they want to move to the next period until you instruct them to do so. After they click the ‘Yes’ button they will receive their score for the period.

Concluding the simulation

You may choose to limit how much information you provide to participants about the length of the simulation (there is no limit to how many periods you play). This is because participants may attempt to “game” the simulation by dumping allowances on the market or engaging in other behaviors that they believe may provide a short-term score increase. If time is not a factor, you may wish to continue the simulation until you feel participants understand the concepts. Once the simulation ends, you should collect the final scores and begin a discussion about what participants learned.

Registry application

Entering transactions

The simulation includes a Registry application (see Figure 1) to publish information about all market activity. The Registry application (ETSimRegistry.exe) is located in the **Registry** folder of the simulation files. Upon opening the registry, you will need to select either the CO₂ or SO₂ scenario, and select the power plants which are being used in the simulation. To modify the list, you can click the **Select power plants** button on the toolbar and select the necessary plants from the list. Once the simulation has begun and two participants have agreed on a trade, you should enter the information, selecting a selling and buying participant and specifying whether allowances or offsets (in the CO₂ version) are being traded, along with the quantity and price of the trade. After all information has been entered, click the **Save** button (i.e., the green check mark).

Recording scores

At the end of each period participants should report their score for recordation in the Registry application. You can record either the period score or the average score (both are provided); however, you should record only one score for each period, and you should record the same type of score, period or average, for the entire simulation.

Advancing to the next compliance period

When you instruct participants to advance to the next compliance period, you must also advance in the Registry application. You can advance to the next period by clicking the **Advance to next period** button on the toolbar.

Changing simulation settings

As facilitator, you may change certain settings in the simulation. By clicking the **Data options** button on the toolbar you can edit some program-specific values. Changing the data settings will modify the "ETSimData.xml" file located in the bin folder. If changes are made to the data settings, you will have to distribute a copy of the simulation that contains the changed file to all of the participants. If all of the participants already have the simulation, you may simply distribute the changed ETSimData.xml file. Each participant will need to replace the existing file with your revised file. Failure to ensure that all participants have the same data file will result in different game play and scoring for participants that do not have the updated file.

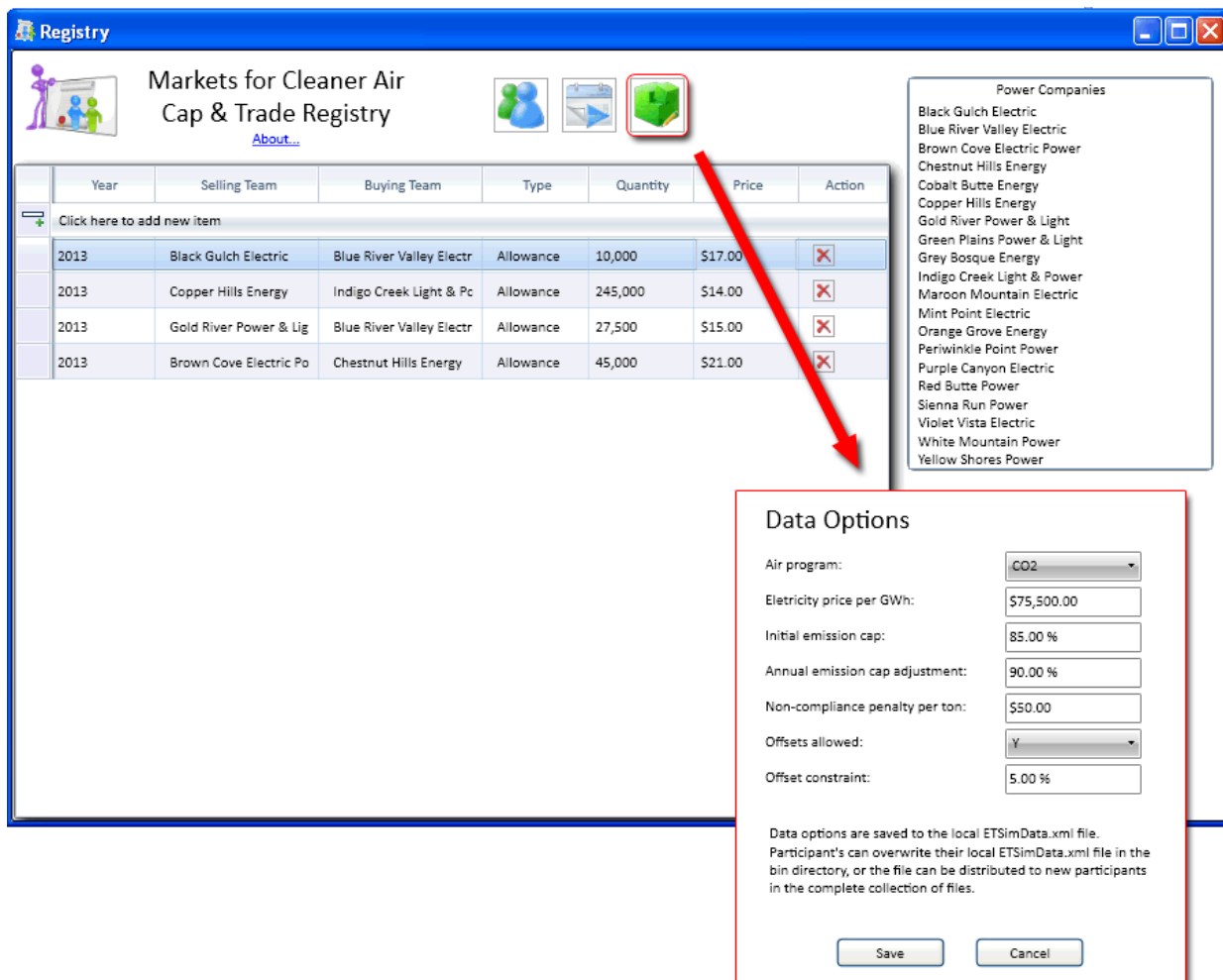


Figure 1: Registry application

Frequently Asked Questions

(you should also review the FAQs from the Participant's Guide)

1. Exactly how is the score determined? Why is the exact formula not enumerated?

As noted earlier, the score is primarily based upon several weighting factors and economic and environmental performance:

- Did the power plant meet consumer demand for electricity
- Did the power company comply with the allowance/offset holding requirements
- Did the power company remain profitable
- How large is the participant's surplus of allowances and offsets relative to the initial allowance allocation
- How significantly did the participant's profit ratio change before the initiation of the cap and trade program

Because the objective of the simulation is to reduce emissions in the least expensive manner, the change in profit ratio and the banked allowances (over compliance) will affect the score.

The exact score algorithm is not shared with participants because the algorithm can change based on the configuration or data settings, and because participants may try to "game" the system to maximize their score. As facilitator, you may choose to respond to questions about scoring by emphasizing that the score is based on meeting demand, and reducing emissions cost effectively.

2. How many years or periods should be played?

There is no specific number of periods for which the simulation should be run. You should be able to run the simulation for as many periods as required for instruction. In addition, informing participants of a set number of periods could lead to a market crash in the last period as participants try to sell off banked allowances in an attempt to influence the score.

3. When should participants advance to the next period?

As facilitator, you must determine when to advance to the next period. The two options outlined in this guide are to either monitor activity and provide a warning as activity dies down and then move to the next period, or to set a time limit for each period. You may employ other methods, however, it is recommended that you explain the method to the participants and remain consistent throughout the simulation.

4. What is the difference between the advanced and basic versions of the simulation?

The advanced version contains "events" which can impact the experience of participants in a range of ways. There are temporary events such as an increase in steel prices which may impact the cost of air pollution control technologies or a temporary change in demand due to specific circumstance. There are also long-term events such as the building of a new factory or closing of an old one that can affect demand for the entire simulation. The events can be different for different participants and force participants to react to events that are similar to what might happen in the real world.

Additionally the advanced version requires that participants subject CO₂ offset projects to a review process (i.e., a random number generator within the simulation determines if the project is accepted or rejected). Rejected projects yield no offsets but incur project design and development costs which are less than the full cost of the project. These costs are expressed as a percentage on the **Offset Projects** window.

5. Which score should be recorded in the Registry application?

You may choose to record either the period score or the average score. However, the same type of score, period or average, should be recorded throughout the simulation.

6. Does it matter which participants or teams of participants get assigned to which power company?

No, assignments can be made in whatever manner you as facilitator deem best. Each power company will have a different mix of units. The allowances are assigned proportionally so that companies initially emitting more will have more allowances. You may want to select power plants from different regions of Ecoland (see the *About Ecoland* section of the *Participant's Guide*) to ensure power plants have heterogeneous costs.

7. Where do the costs in the simulation come from?

The costs are based on real-world costs with an Ecoland dollar-to-US dollar exchange rate applied. The data sources are displayed in the simulation data file ("ETSimData.xml" file located in the bin folder).

Topics for Discussion, Ideas for Assignments, and Information Resources

A. Additional questions to be used for class discussion or testing purposes

1. What was your participant's strategy for implementing the emission reductions?
2. Did the strategy work? Why or why not?
3. What information did you use to develop your strategy?
4. Did you adjust your strategy? If so, what impact did the adjustment have?
5. Would you adopt a different strategy next time? If so what would it be?
6. How did you decide whether or not to buy or sell allowances? How did you establish price?
7. What other factors would you have to consider if developing a compliance strategy at a real power company?
8. How does this approach differ from other policy approaches (e.g., command and control)?
9. Compared to other policy approaches, how does this approach reduce the overall cost to society to reduce emissions?

B. Additional informational resources**1. Internet resources**

- a. EPA's cap and trade website: www.epa.gov/captrade
- b. EPA cap and trade progress reports:
www.epa.gov/airmarkets/progress/progress-reports.html
- c. Regional Greenhouse Gas Initiative: www.rggi.org
- d. EU Emission Trading Scheme: www.ec.europa.eu/clima/policies/ets
- e. Stockholm Environment Institute & Greenhouse Gas Management Institute's carbon offset information: www.co2offsetresearch.org/policy
- f. Climate Action Reserve's offset program manual:
www.climateactionreserve.org/how/program/program-manual
- g. World Resources Institute offsets information: www.wri.org/topics/offsets

2. Reports and journal articles

- a. Chestnut, Lauraine G., and David M. Mills. (2005) "A fresh look at the benefits and costs of the US acid rain program." *Journal of Environmental Management* 77, 252-266.
[\[www.epa.gov/airmarkets/resource/docs/bandcofarp.pdf\]](http://www.epa.gov/airmarkets/resource/docs/bandcofarp.pdf)
- b. Ellerman, Denny A., Paul L. Joskow, and David Harrison, Jr. (2003) *Emissions trading in the U.S. Experience: Lessons, and Considerations for Greenhouse Gases*. Washington: Pew Center on Global Climate Change.
[\[www.pewclimate.org/docUploads/emissions_trading.pdf\]](http://www.pewclimate.org/docUploads/emissions_trading.pdf)
- c. EPA. (2003) *Tools of the Trade: A Guide to Designing and Operating a Cap and Trade Program for Pollution Control*. Washington: US EPA.
[\[www.epa.gov/airmarkets/resource/docs/tools.pdf\]](http://www.epa.gov/airmarkets/resource/docs/tools.pdf)
- d. Napolitano, Sam, Gabrielle Stevens, Jeremy Schreifels, and Kevin Culligan. (2007) "The NO_x Budget Trading Program: A Collaborative, Innovative Approach to Solving a Regional Air Pollution Problem." *The Electricity Journal* 20(9), 65-76.
[\[www.epa.gov/airmarkets/resource/docs/noxelecjournal2007.pdf\]](http://www.epa.gov/airmarkets/resource/docs/noxelecjournal2007.pdf)
- e. Napolitano, Sam, Jeremy Schreifels, Gabrielle Stevens, Maggie Witt, Melanie LaCount, Reynaldo Forte, and Kenon Smith. (2007) "The U.S. Acid Rain Program: Key Insights from the Design, Operation, and Assessment of a Cap-and-Trade Program." *The Electricity Journal* 20(7), 47-58. [\[www.epa.gov/airmarkets/resource/docs/US%20Acid%20Rain%20Program_Elec%20Journal%20Aug%202007.pdf\]](http://www.epa.gov/airmarkets/resource/docs/US%20Acid%20Rain%20Program_Elec%20Journal%20Aug%202007.pdf)
- f. Tietenberg, Tom. (2010) "Cap-and-Trade: The Evolution of an Economic Idea." *Agricultural and Resource Economics Review* 39(7), 359-367.
[\[http://ageconsearch.umn.edu/bitstream/95836/2/tietenberg%20-%20current.pdf\]](http://ageconsearch.umn.edu/bitstream/95836/2/tietenberg%20-%20current.pdf)